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USE OF LOADING COILS ON CABLES WITH POLYVINYL-CHLORIDE INSULATION EMPLOYED IN INTRARAYON COMMUNICATIONS NETS

Vestnik Svyazi
[Communication News],
No 8, 1953, Moscow,
Pages 15-16

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The article discusses a method of loading cable lines of intrarayon communication and considers a method of mounting the inductance coils.

At the present time the networks of the intrarayon communication (VRS) at the present time make widespread use of cables (wire pairs) with polyvinyl-chloride insulation. The industry produces such cables under the trademark PRVPM with copper wires 0.8, 1, and 1.2 mm in diameter. The radio thickness of the insulation in the cables is respectively 1 ± 0.2, 1.2 ± 0.2, and 1.4 ± 0.2 mm.

The electrical parameters of the nonloaded cables with polyvinyl-chloride insulation at a temperature of ± 20° are given in Table 1.

Table 1

Type of cable	f kc	β mnep/km	α radian/km	Z ohm	$-\varphi$	Z cos φ ohm	-Z sin φ ohm
PRVPM-0.8 mm (R_o = 72.2 ohm/km;	0.3	88	0.084	587	42°30'	432	396
C = 0.111 mfd/km;	0.8	143	0.141	353	41°24'	265	234
L = 0.816 mh/km)	2.4	237	0.263	207	38°06'	163	128
PRVPM-1 mm (R_o = 47 ohm/km;	0.3	72	0.069	467	42°05'	356	312
C = 0.114 mfd/km;	0.8	115	0.117	290	40°32'	220	188
L = 0.802 mh/km)	2.4	185	0.223	166	35°40'	135	97
PRVPM-1.2 mm (R_o = 32.8 ohm/km;	0.3	60	0.059	386	41°41'	289	257
C = 0.116 mfd/km;	0.8	96	0.101	237	39°22'	183	151
L = 0.792 mh/km)	2.4	148	0.197	140	32°55'	118	76

According to Rukovodstvo po stroitel'stvu i remontu sooruzheniy vnutrirayonnoy svyazi [Instructions for the Construction and Repair of Intrarayon Structures], Part II, 1949, Svyaz'izdat, the attenuation in the section comprising the intrarayon network telephone subscriber set and the interurban telephone station of the rayon central station should not exceed one nep at a frequency of 800 cycles, and for certain rayons 1.6 nep at the same frequency (Figure 1). The maximum length of the line from the telephone set of the subscriber of the intrarayon network to the interurban rayon central telephone station, corresponding to these norms, is indicated in Table 2.

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Table 2

Maximum permissible length of line, in km

Type of cable	Single-step construction of net: b = one nep, b_{line} = 0.5 nep	Single-step construction of net: b = 1.6 nep, b_{line} = 1.1 nep	Double-step construction of net: b = 1.6 nep, b_{line} = 0.85 nep
PRVPM-0.8 mm	3.50	7.70	5.95
PRVPM-1.0 mm	4.35	9.55	7.40
PRVPM-1.2 mm	5.22	11.50	8.90

It is evident from the table that the maximum telephoning distance using cables with polyvinyl-chloride insulation does not exceed 11.5 km. Such a distance is inadequate for rayons with large territories. This distance can be increased either by installing repeaters, which is difficult in practice, or by artificially increasing the inductance of the line.

The inductance is usually increased artificially by loading the telephone network. Essentially the method consists of inserting in the cable line inductance coils at equal distances from each other, as shown schematically in Figure 2. A loaded line can be considered as consisting of individual links, each link containing a coil and a section of cable on each side.

To load lines on the intrarayon communication networks the Russian industry produces coils which have an inductance of 70 mh. The loading spacing S (distance between coils) is taken to be 1 km. Under these conditions the channel occupies a frequency band from 300 to 2,400 cycles.

The inductance coil has a cast iron dish (case) with a cover and 2 PRVPM paired lead-in wires. Inside the dish is a toroidal core, made of pressed powdered magnetodielectric. The core carries a winding made of insulated copper wire. The core is impregnated with a substance containing rosin, paraffin, and natural rubber.

The electrical parameters of cables with polyvinly-chloride insulation, loaded by 70 mh inductances with a loading spacing of 1 km are given in Table 3.

Table 3

Type of cable (Loading system: L_S = 70 mh, S = 1 km)	f kc	β mnep/km	α radian/km	Z ohm	$-\varphi$	Z cos φ ohm	-Z sin φ ohm
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	0.3	50.4	0.1704	910	$16^\circ 30'$	883	258
PRVPM-0,8 mm	0.8	61.0	0.4561	865	$8^\circ 18'$	850	125
	2.4	100.8	1.4853	1092	$5^\circ 05'$	1099	110

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0.8 mm diameter be laid over a route 6,810 m long. Dividing 6,810 by 1,000 we obtain 6.81. Consequently the number of spacings will be 7. Hence the length of the practical spacing will by 6,810: 7 = 973 m, and the length of half the spacing will be 973:2 = 487 m. Thus the outside coils should be installed at distances of 487 m from each of the stations and the intermediate ones at a distance of 973 m from the outside coils and from each other.

Deviations from the selected loading spacing should not exceed 2%. For example, if the loading spacing is one km, the coils should be installed not closer than 980 and not farther than 1,020 m from each other.

Before installing the inductance coil one checks that its lead-in wires are in working order and the insulation resistance between the wires of these conductors and between the coil windings and the cast-iron case is measured.

If a cable with polyvinyl-chloride sheath is laid mechanically, pits measuring not less than 0.75 x 0.75 m and 0.7 -- 0.8 m deep are dug manually at the locations where the inductance coils are to be installed. The bottom of the pit is levelled and a recess is formed in it in such a way that the lead-in wires can be located on the bottom of the pit with a certain amount of slack (bend).

Using the lead-in conductors, the inductance coil is connected in series with the wires of the loaded cable, paying particular attention to the thoroughness with which the splices are made. The coil and the adjacent cable sections are then covered with a layer of sifted earth or sand not less than 10 cm thick and is protected against mechanical damage, by bricks, concrete slabs, boards impregnated with bitumen, etc.

It is best to install the induction coil starting with any one station and using the following sequence. At the place where the first coil is installed (at a distance of half a loading spacing from the station) the section of the cable is checked on the station side for open circuits and for grounds. Then a previously checked coil is inserted. After this one goes to the pit in which the second coil is to be installed (at a distance of one loading spacing from the first coil) and the section cable is checked from that point back to the station. If the checked section is in working order, the second coil is connected and the first pit is filled with earth or sand. The second pit is filled after checking the cable from the third pit etc.

It is also possible to perform the installation using 2 brigades working simultaneously from both stations towards each other. However, no matter what method of organization is used, it is necessary that the route be measured and that the location of the coils be established beforehand, using a practical loading spacing previously chosen. If this condition is not satisfied, the length of the splice section may differ considerably (more than 2%) from the practical spacing; this will make it necessary to reinstall the coils already installed.

After completing the installation of the induction coils it is necessary to determine by electric measurements the insulation resistance, the d-c loop resistance, and the asymmetry of the loaded circuit. The document accompanying the cable should contain the following data: section in which the cable is laid, length of the section, type of cable, loading system and number of induction coil installed, date cable was laid, last names of persons installing the induction coil and results of electrical measurements.

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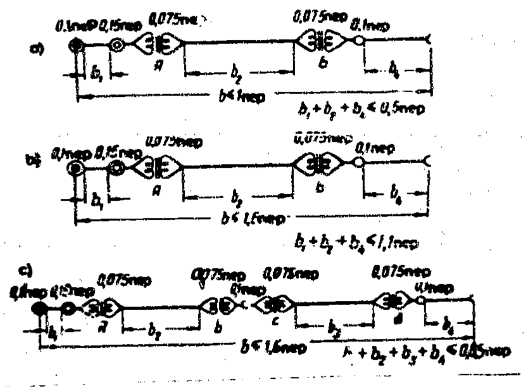

Conventional Symbols

- interurban telephone station of rayon central
- central telephone station intrarayon communication
- telephone substation intrarayon communication
- subscriber's telephone set
- line transformer

Figure 1. Distribution of attenuation in intrarayon communication net. a, b, single-step construction of net; c, 2-step construction of set.

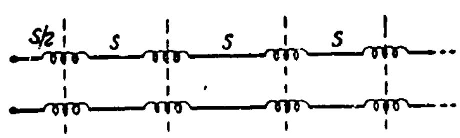

Figure 2. Diagram of loaded cable line.

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